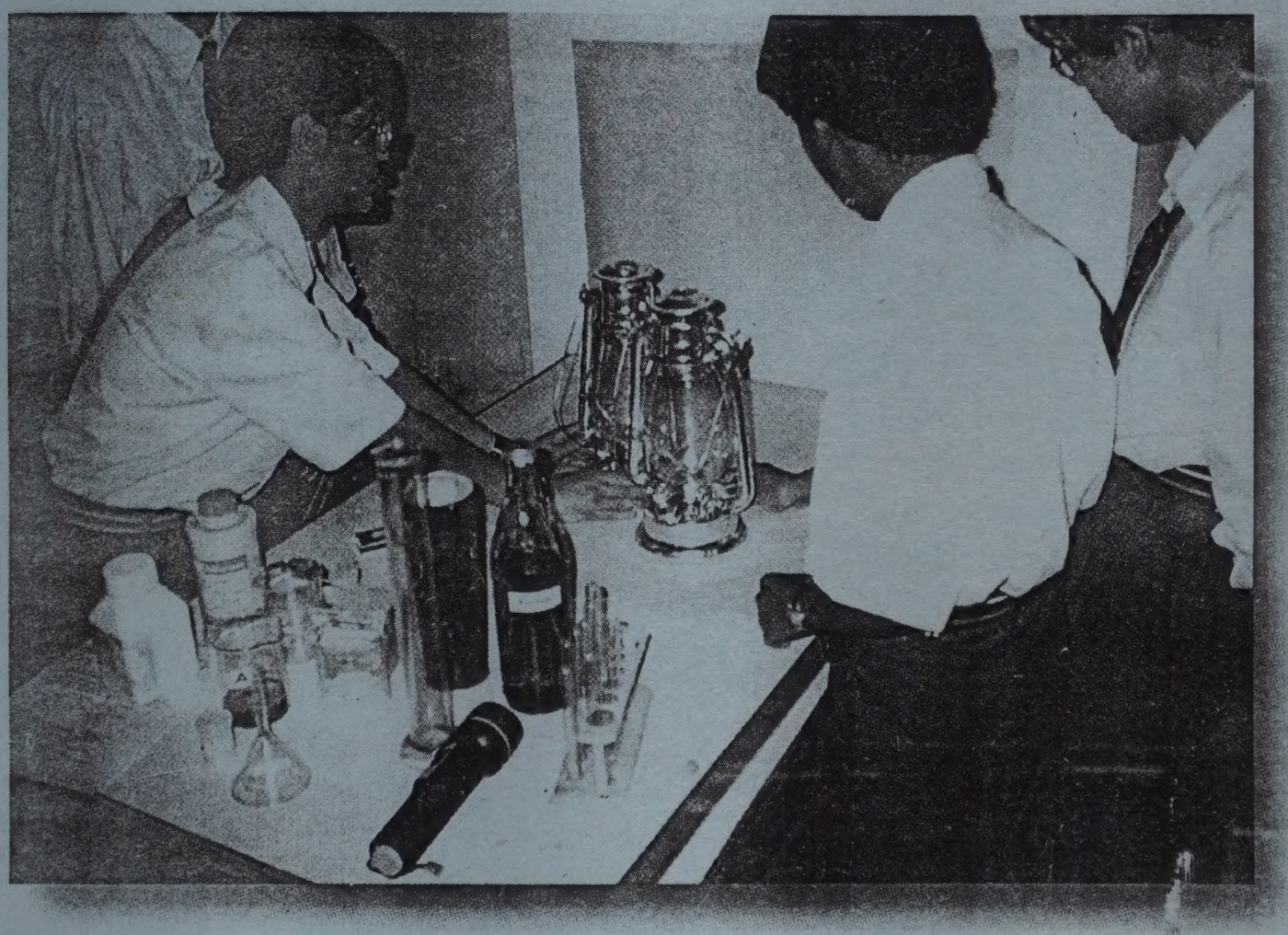
PROMOTING STUDENTS' SCIENTIFIC & TECHNOLOGICAL THINKING

- DEVELOPING SKILLS & ATTITUDES CONCERNING OUR ENVIRONMENT



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Preface

During March 1998 a small but enthusiastic group of Nepalese science teachers met to learn about the UNESCO/ ICASE 2000 + initiative. Small groups then evaluated some STL materials written in the region and elsewhere, before developing their own materials relevant for Nepal. Eight scripts were produced and these were edited into a consistent format for trial in Nepal secondary schools. These units are very appropriate for use in a country with an expressed curriculum emphasis on applications of science to the environment and needs of a rapidly developing society. All the units focus on some applications of science to the local community.

The Centre for Literacy Enrichment in Environment, Science and Technology (CLEST) in Nepal has defined STL as **"the ability to understand and relate basic scientific knowledge and skills to everyday life and community needs in ones own environment"** CLEST seeks to promote relevant and meaningful environmental science education in schools and the community with an emphasis on practical and personal involvement.

The Nepal workshop was the first national STL workshop anywhere in the world, all previous ones having been regional. It was organised by Dr Sharada D Maharjan (CLEST), assisted by Mrs Annette Guveya (UNESCO, Bangkok), Dr Hridaya Bajracharya (Little Angels' School), Dr Jack B. Holbrook (ICASE) and Patrick A. Whittle (ICASE). The workshop could not have taken place without the generous and practical support of the Principal and staff of Little Angels' School, Hattiban, Kathmandu, where it was held, and practical support of the Royal Society of Chemistry, C.E.C., I.C.A.S.E. and U.N.E.S.C.O. This product of the workshop owes much to the creative initiative , interaction and hard work of the participants whose names appear in the individual units and all those others who contributed or provided feedback on the draft units.

The final publication of these materials has been a collaborative effort on the part of C.E.R.I.D., C.L.E.S.T., I.C.A.S.E. & U.N.E.S.C.O. The book was financed by U.N.E.S.C.O. under the auspices of the Tribhuvan University Centre for Educational Research, Innovation and Development (C.E.R.I.D.), Tripureswor, Kathmandu.

The materials were edited and the book was prepared by
Dr Sharada D. Maharjan and Prof. Patrick A. Whittle.
October 1998

Acknowledgments

Unit 3: "The Naulogaon Free Sweets Story" is based on an original idea from the material which was produced at the Harare Generator, entitled "Free Soap" (published by ICSU, 1994).

Unit 7: student resource sheets use extracts from national newspapers in Nepal including the "Kathmandu Post" and the "Rising Nepal".

All the other material was developed empiricially in Nepal, using data from a variety of sources, too numerous to identify, although a full bibliography of references is provided in appendices.

The contributions from all theses sources is duly acknowledged by the writers.

We acknowledge with thanks the various inputs and feedback from staff and students of : Bhanubhakta Memorial m.v., Budanilkantha School, Gandaki Boarding School, Global Collegiate School, Little Angels School, River Valley School, Saraswati m.v., World Vision School & College.

Cover photographs by S. D. Maharjan and P.A. Whittle

1998 CLEST (Centre for Literacy Enhancement in Environment, Science & Technology).

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CONTENTS

Introduction to the Materials

The Purpose of the STL Materials

These units are designed :

i) to supplement regular science teaching -
   - you may select and use one unit (or part of it) with any one class.
ii) to involve more students actively in the lesson -
   - exploiting the natural interests of girls and boys in their society
iii) to meet a wider range of educational objectives than usual -
   - these are the Nepal curriculum aims that are not easily examined
iv) to be challenging, thought-provoking and stimulating
   - students are encouraged to apply their imagination and creativity
v) to provide opportunity for formative and summative assessment
   - guidelines are provided for assessment activities.

How to Use the STL Materials

Select a unit which is on a topic of your interest and which matches an appropriate topic on the science curriculum for one of the classes you are teaching. Carefully read through the whole unit, including students' and teachers sections and note if it may need minor modification for your situation or the level of the class. Check what materials or preparation are required and decide how you will use the student guide, which could be photocopied for each group or summarised on the blackboard.
Estimate how many lessons will be needed and carefully plan the introductory lesson in order to familiarise the class with the student-centred approach that will be used. Make any necessary preparations e.g. collecting materials or advance information. During the group activities provide all the guidance, support and help that the students require, and encourage them to record even the simplest or negative results of their experiments or inquiries. Some of the activities depend upon cooperation of other students and members of the community - these must not disrupt other lessons or regular school activities. Students should be encouraged to continue the projects in their own time and relate them to the community - in most cases there is a message worth passing on to the other students in the school or to the community.

Evaluating the STL Materials

We can assess students, but we may also evaluate the materials or teaching methods. Therefore, in addition to assessing the progress of individual students in working through one or more of these projects it is a useful exercise at the end of a given unit to reflect on what has been achieved in relation to the stated aims of that activity. For this reason, Appendix II includes a copy of the Evaluation Form which was used during the trial of these units in Nepal. It may be photocopied and used as it stands, or you may wish to use it as a basis for your personal evaluation of the materials.

Some teachers may wish to conduct research by carrying out a formal evaluation of STL materials in their own area, and could adapt the form for their own purposes. How did you find the approach - more preparation and less formal classroom teaching ? What did the unit achieve ? Would you modify the unit for next year ? An important component of any evaluation is the reaction of the students to a new approach to learning about the applications of science in their own society. It could be more important to them, in the long run, than passing their formal examination.

Writing your own STL Materials

These materials were written by small groups of Nepali science teachers. They first examined some STL units written in other countries, then discussed the relevant and irrelevant aspects of those for Nepal. Next they held a brain-storming session about their own preference for an STL topic. After that they sat down and drafted a unit on the basis of : (i) aims of the activity, (ii) background information,
(iii) detailed, challenging activities for the students,
(iv) concepts involved and (v) materials required ,
(vi) possible assessment procedures .
They looked up data and collected information, then modified their first drafts before sharing them with others. Finally, after trying them out in school, further modifications to the units were made before they appeared in this book.

Perhaps you can get together with science teachers from the cluster of schools in your own locality, or in your local branch of the science teachers association, to develop a unit of your own which is related to some current issue in your own area.

Unit 1 Allow Me to Breathe Comfortably

An investigatory, experiment-based, problem-solving activity

Introduction

This unit introduces students to some of the factors which may be causing air pollution in their environment and leads them to examine some of the air pollutants. Students are made aware of air pollution prone areas and asked to suggest ways in which they can help their community to minimise air polluting activities and their effects.

Educational Aims

The purpose of this unit is to expose students to the following opportunities :

1. Formulating the causes and effects of atmospheric pollution
2. Planning to investigate some atmospheric pollutants
3. Performing some simple experiments
4. Appreciating the importance of taking fresh air
5. Valuing and developing the habit of taking fresh air
6. Participating and cooperating as a member in the group
7. Suggesting ways of minimising air pollution
8. Sharing their knowledge with people in the community.

Scientific concepts involved:

composition of air	temperature effects	precipitation, filters
products of combustion	atmospheric pollution	density of air
exhaust control	gaseous pollutants	ecological balance

Teaching / learning activities suggested:

Class discussion, group discussion, group investigation and experiment.
After more class discussion, community surveys/information activities may be done.

Teaching / learning resources required :

Large plastic bags	Filter papers	Indicators	Lime water, tape
Grease or glue, tape	Magnifying glass	Face masks	Cigarette/incense stick
U-tube, side- arm tube	Washbottles	Funnel	(ice, if avaialble)
Anhydrous copper sulphate	Suction pump (or aspirator)		

Background information

Air pollution is the undesirable change in physical, chemical, or biological features of air. The substances that pollutes air are called pollutants. These pollutants are of various kinds - some are particulate matter like dust particles or smoke - others may be undesirable gases. A high concentration of these substances in the air will have an effect on all living beings including an effect on the quality of human life.

The most common causes of air pollution, depending where you live, are probably exhaust gases from moving vehicles, burning fuels , factories and industrial processes, dust, smoke and gases from domestic fires or agricultural activities, or cigarette smoke in crowded rooms.

The presence of extra gases and particles makes the composition of the atmosphere different from natural, normal, fresh air. Polluted air may include different amount of various gases such as carbon monoxide, carbon dioxide, nitrogen dioxide, sulphur dioxide, hydrogen sulphide and it may also contains dust, grit and other particles from grinding industries.

Polluted air has an adverse effect on all living beings, plants or animals, including human beings, by interference with, or poisoning, the gaseous exchange mechanisms. It is especially harmful to the human respiratory systme, often causing discomfort or serious health problem. Air pollution is primarily a major problem of urban people , because the areas are crowded, often with improper housing, decaying waste, many old vehicles, and industrial effluents. As a result the whole community suffers from air pollution and related health problems.

Your task:

- Describe to the group your personal experience of any examples of air pollution
- Discuss effects of air pollution in your community (medication necessary....)
- Devise methods of collecting and testing some air pollutants
- Perform the developed activities - keep records of these findings
  (test for the presence of particles, gases, e.g. CO, CO_2, SO_2, - nitrogen oxides .....)
- Develop a questionnaire to consult people in the community about air pollution
  (where they notice it, what effects it has, what should be done about it.....)
- If possible refer to sources of information to check your findings / observations
- Suggest ways and means to help your community to minimise air pollution

Follow-up activites for reducing pollution

- Planting trees in the school compound or locality
  Conduct a poster campaign to :
- Encourage solar cookers and use of biogas - long chimneys for factories
- Encourage use of lead free petrols in vehicles - no smoking zones.

Teachers' guide: Unit 1 Allow Me to Breathe Comfortably

Preparations for these activities include :

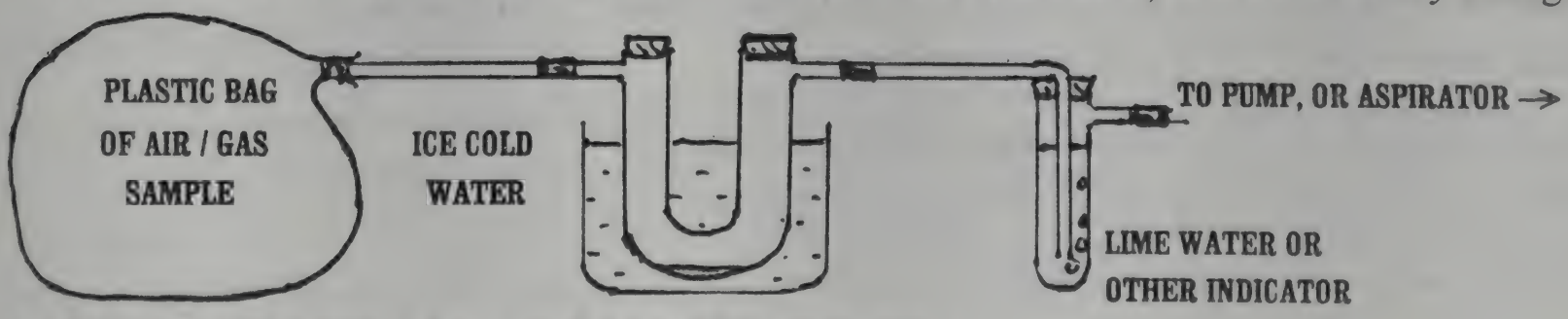
- provide some simple apparatus / materials / experiments for collecting and testing samples of air and identifying some pollutants in the air
- collect information about local atmospheric pollution and its origins
- be ready to suggest measures to help the community minimise air pollution

Teaching strategy

1. Begin the activities by sharing in class some past experiences of various air pollution induced incidents, accidents or illnesses which they experienced, observed or heard of .
2. Divide the class into groups and ask them to share their own experiences of air pollution. Help each group to discuss methods of investigating air pollution, to devise and conduct suitable experiments and tests of the samples. Encourage students to write down their plan, all observations, results and the findings of their experiments.
3. Draw the attention of the whole class towards the investigations by each group.
4. Help the class to draw conclusions and discuss the adverse effects of air pollution .
5. Ask students to suggest the ways which they think relevant for reducing pollution .
6. Discuss methods of disseminating this information in the community.

Some possible students' activities

1. Identify particles in air by exposing greased papers (examine them after 1-5 hours) e.g rooftop, roadside window, school garden, near factory, chimney.... and draw conclusion.
2. Checking for sulphur dioxide : count numbers of lichens/unit area in two different places.
3. Testing for CO_2 and other gases : set up the apparatus using a suction pump or aspirator to draw collected air samples through lime water (or other indicators) and.observe any changes.



Additional Information : major pollutants are :

Carbon dioxide	Produced as a result of combustion of fuels and during respiration of living beings. Too much in the air we breathe may cause headache and health problems -also global warming due to green house effect
Carbon monoxide	Gas which is produced as a result of incomplete combustion of fuels. It reduces the ability of the blood to take oxygen
Sulphur dioxide	Produced from coal burning and combustion of petroleum products. With water it makes H_2SO_4 which corrodes metal, affect stones / marble. It has a very noticeable effect on lichens.
Oxides of nitrogen	Produced by incomplete burning of fuels. Also causes health problems as it reduces the oxygen carrying capacity of the blood

Achieving and Assessing the Objectives

These activities may be best assessed formatively, rather than summatively , although there could be opportunities for some written or creative work at the end of the project.

The following table summarises the major objectives for the suggested activities and some possible means of assessment.

Objective	Activities to achieve this:	Assessment procedures
Formulate cause/effects of air pollution	Exchange experiences, discuss and draw conclusions (report)	Note participation and concluding reports
Plan to investigate air pollutants	Discuss and plan activities to find and test some pollutants	Practicability of the planned investigation
Perform simple tests and experiments	Carry out tests on some pollutants found in the air	Successful tests completed and summarised
Appreciate value of non-polluted air	Discuss in group / community and comparison of experiences	Willingness to express and share experiences
Explain the effects of common pollutants	Enquiry, library search and individual reading	Creative writing or drawing poster
Co-operating as member in a group	Actively taking part in group discussion and work	Peer observation and group achievement
Share knowledge in the community	Discuss aspects of air pollution in the community	Involvement in minimising pollution in the community
Suggest ways to minimise pollution	Encourage members of the community to reduce air pollution	

Authorship

This unit was developed by

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Mr Yamuna Mahat , River Valley School, Kirtipur

Mr Keshar Man Tamrakar, Budhanilkantha High School

Unit 2 Improving Kerosene Lamps
An investigative experimental study

Introduction

This unit will involve students in a study of lamps and flames and a search for the choice of any material or substance that can help to increase the brightness of light from a kerosene lantern. They will also attempt to reduce the rate of using fuel in the lamp. The project will involve experimental, technological and socio-economic considerations related to the use of additive(s) as a means of increasing the brightness of the lantern and reducing the fuel consumption.

Educational Aims

The purpose of this unit is to expose students to the following opportunities:

1. Conduct a survey of locally available light sources and appreciate social and economic factors influencing choice of fuel and types of lamps used for domestic lighting.
2. Investigation of the nature of flames and burning
3. Involvement in planning and conducting a guided investigative project
4. Suggesting steps and devising an experiment to find out the effect of adding substances to the kerosene oil in a lantern to try to increase brightness and reduce consumption
5. Presentation of scientific data and interpretation of findings
6. Communicate results orally and in writing, in relation to social and economic factors
7. Cooperating as a member of a small group

Scientific concepts involved:

ignition temperature heat and rate of combustion total and partial combustion
products of combustion ionization emission spectra colour/wavelength
luminosity shadow casting light intensity photometric comparison
inverse square law focal plane fuel consumption rate pollution

Teaching / learning activities suggested:

Class discussion, group discussion and community survey of lamps/fuels
Planning, conducting and reporting investigative experiments and tests
Developments of suitable handouts or posters for use in school and community

Teaching / learning resources required:

Lantern/lamps (identical type, size, wick) kerosene oil (1 litre) torch, candles
Common powders (e.g. chalk, sugar, table salt, talcum powder...) scale thermometer
Concave mirrors (same size and focal length) pencil in stand screen balance

Background information

Quality of life is improved by using artificial light in the evening, and traditionally in Nepal most homes used oil lamps (burning mustard oil, or other vegetable oils) in a batti. People in more remote villages still use kerosene lantern or pressure lamp as the main lighting device. If you do not have electricity, the kerosene lantern is handy and more portable than candles, but it may create some air pollution during the combustion of the fuel. As a result the glass can become smoked with soot and the brightness of the lamp will be reduced. Who, in your family, has the most sensitively developed skill of correctly adjusting the wick of a lantern ?

The output of light from two different sources can be compared by various methods - either by measuring the energy arriving on a surface, or by Rumford's photometer method which compares the shadows produced by light coming from the two lamps.

It may be possible to modify a kerosene lantern in some way to produce a brighter light, to decrease the consumption of kerosene fuel and to minimise pollution.

Your task:

- conduct a survey in your school of different kinds of lighting devices used at home
- suggest ways in which the light from a kerosene lantern could be improved (consider the glass, reflectors, different wicks, air supply, additives to the fuel.....)
- each group will carry out different types of experiments, from all the suggestions
- record your observation carefully in tabular /graphical form and interpret the results
- demonstrate to other students the effect of modifying your kerosene lantern
- suggest ways in which kerosene lanterns could be improved to increase brightness or effectiveness of the light produced, reduce consumption and minimise pollution.
- you could target the community with your suggestions about using kerosene lanterns.

Follow-up activities

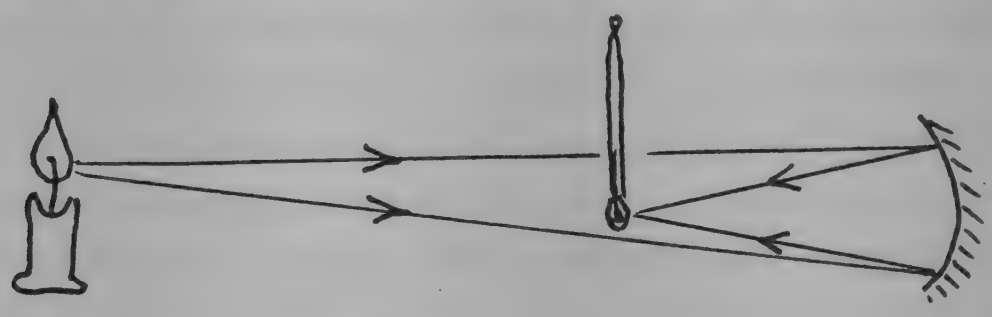
- Prepare and display a poster report, with tables / graphs / charts of your results
- Develop a role play / dramatisation / dialogue to communicate your findings

Student Resource Sheet Unit 2 Improving Kerosene Lamps

[Many of these activities may require a darkened room]

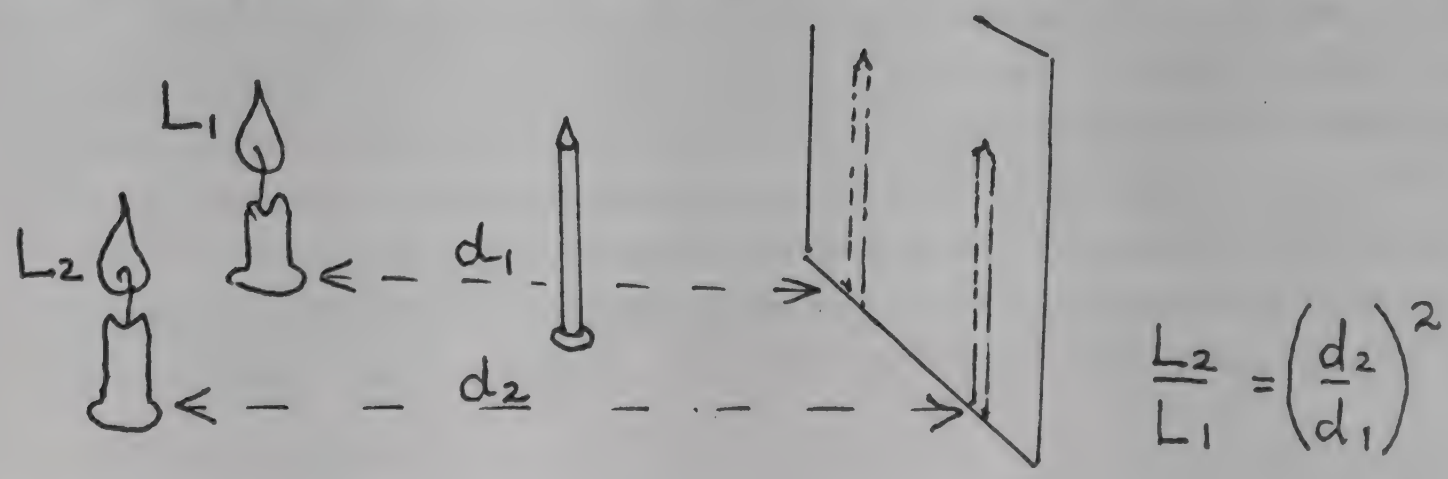
Measuring the energy from a lamp

If you do not have a light sensitive meter (exposure meter) or photometer to measure the light intensity,use a concave mirror to focus an image of the source on a paper, then replace the paper with the bulb of a thermometer bulb at the focus (as shown in the diagram). After a few minutes, the thermometer reading will rise, indicating the level of energy arriving there. To compare the total energy arriving from different lamps you will need to control the distance from the lamps, and the time the light is allowed to fall on the thermometer.



Rumford's method of comparing light intensities

Lamps of different brightness may be compared by adjusting their distance from an object (such as a pencil) and a screen, until the shadows are the same (as shown in the diagram). In order to compare the shadows these must be quite close to each other. Measure the distance of the lamp from the screen: the lamp which is farthest away is the brightest source.



The investigation

1. Use one of the above methods to compare the brightness of different light sources.
2. Investigate factors influencing the intensity of light from one kerosene lamp e.g.
   i) with/without glass ii) different height of wick iii) different diameter wicks
   iv) with reflective aluminium foil or shiny plate behind the lamp
   v) using 100 mls of kerosene with 10g of different additives
   (Note : empty the lamp and rinse it out a little pure kerosene between each test)
3. Make a note of any other variables that are important
   (E.g. air supply, pollution level - can it be tested ? , colour of flame.....)
4. By weighing the lamp before and after use, calculate how much kerosene is used per minute in each case, allowing for any loss of weight of the wick (if burnt).

Preparations for this activity include :

- making available a well-shuttered, darkened (but ventilated) classroom or laboratory
- various candles and lamps, including at least two identical kerosene lantern/lamps
- 1 litre of kerosene, some similar size bottles, and some common powders -
- chalk, sugar, common salt, talcum powder, sodium bicarbonate.....
- scales, balance, thermometers, clock, concave mirror, pencil in stand, screen

Background information

Kerosene oil, also known as paraffin, is a mixture of alkanes which are hydrocarbons with 10 to 16 carbon atoms in each molecule.. Paraffins are petroleum fractions having the boiling point between 175° C and 325°C and are used as fuel in jet aircraft as well as heaters/lamps. The general formula is C_nH_{2n+2}. Kerosene oil has advantage over solid fuels as they leave no residue on combustion and have a higher caloric value (between 1000-2000 kilojoules / kg) compared with coal (600-1800 kJ / kg) and wood which is even less efficient as a fuel.

Generally we consider that ionic salts do not dissolve in kerosene oil which is covalent, but sodium chloride does ionise very very slowly in the fuel. It is possible that slow ionisation plays a role in producing a brighter light and reduced consumption of kerosene.

A flame is a burning, glowing mass of gas in which chemical reactions are taking place. (Detailed examination of a candle-flame could be a valuable preliminary activity - in order to light a candle, a match is used to reach a sufficient temperature to vaporise the paraffin-wax and activate the oxidation reaction, which then releases energy and is self sustaining). Different degrees of oxidisation and temperatures occur in any flame resulting in different emissions of light , from red to yellow to blue (increasing energy levels).
Some chemical ions present in a flame give characteristic colours (used in flame tests): sodium ion -> yellow/orange, potassium ion -> lilac, calcium -> red, copper -> green.

Teaching strategy

1. Ask students to make a survey of light sources used at home by their friends.
2. Demonstrate some different light sources and ask students to examine candle flames.
3. Discuss the purposes of matches, and the nature of chemical reactions in flames
4. Explain the nature of spectral emission of different wavelengths by an excited ion.
5. Students can be asked to predict how improved kerosene lamp may be possible and in groups to suggest and plan an investigation of kerosene lamps. (Their suggestions may be many and varied, and different groups can pursue different lines of inquiry)
6. Guidance should be given about this series of experiments and in particular some how different additives to the kerosene can be tested.
7. Interpretation and presentation of the results will also require guidance.

Achieving and Assessing the Objectives

These activities may best be assessed formatively, by observing individual participation in the group activities, rather than summatively, but there are ample opportunities to set some descriptive or creative written work during and after the project, and to check the extent to which students can isolate the factors influencing the quality and efficiency of lanterns..

Objective	Activities to achieve this	Assessment procedure
Survey local light sources to appreciate socioeconomic factors influencing choice	Interviews	Written or oral report of survey
Investigation of the nature of candle flames and burning	Experiments on candles, observe and test flames	Written or oral report of the activity
Involvement in planning and conducting a guided investigative project	Group brain-storming	Written or oral action plan
Devising/conducting an experiment to find effect of additives to kerosene.	Experiments on brightness of kerosene lantern/lamp	Contributions to group report
Presentation of scientific data and interpretation of project findings	Tabulating results and presenting graphically	Poster display and oral presentation of group findings
Communicate results orally and in writing, in relation to social and economic factors	Develop information in form of a handout or poster	Outcomes of the project and final product
Cooperating and participating as a member of a small group	Participation in corporate activities of group	Involvement evident or leadership potential shown

Authorship

This unit was developed by

Mrs Ishwari Dhungana Bhanubhakta m.v. , Pani Pokhari

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Unit 3 Let's Enjoy the Music

An investigative experimental study

Introduction

This unit will involve students in a practical study of different sources and kinds of sounds, finding out which natural and man-made sounds their friends like and dislike, and participating in a debate about personal freedom to enjoy music as loudly as one wishes as opposed to the to obligation to respect the wishes and requirements of other members of the community.

Educational Aims

The purpose of this unit is to expose students to the following opportunities:

1. Investigation of the variation in sounds produced in nature, music and technology
2. Survey of the kinds of sounds other students like and dislike in different circumstances
3. Developing and testing a theory about acceptable sound levels
4. Awareness of individual differences in responding to sound stimulus
5. Communicate results orally and in writing to others
6. Cooperating as a member of a small group

Scientific concepts involved:

Frequency/hertz	sound waves	harmonics	musical scale	rhythm
larynx, eardrum	birdsong	sound-recording	loudspeaker power/ watts	
resonance	loudness/decibels	noise threshold	sound pollution and insulation	

Teaching / learning activities suggested:

Class discussion and group discussion of varieties of sounds
School survey of sounds which students like and dislike most
Experimental investigation of some musical instruments and sources of sound
Testing other students' responses to a variety of sounds
A formal debate about freedom to enjoy music as loudly as one likes
Developments of suitable handouts or posters for use in school and community

Teaching / learning resources required:

Musical instruments	cassette-tape recorder and tapes		portable radio
electric bell, buzzer	whistles and horns	school bell	temple bell

Background information

Sounds are very important to us for communication and enjoyment, within certain limits.
What is your favourite music ? Are there any other sounds that you enjoy a lot ?
Can you identify any wild animal , bird or insect when you hear it ?
Do you enjoy listening to a circular saw cutting timber or an aircraft taking off ?
Have you ever been asked to reduce the volume of your radio which you are enjoying ?
Human beings can hear sounds of frequency between 20 hertz and 20,000 hertz (c/s)

Musical instruments are designed to produce sounds of definite frequencies, which can "harmonise" when played together. The basic musical scale runs from Sha (Middle C), which is 256 Hz, up to higher Sha (C'), which is 512 Hz . If played at the same time our ears can detect that these frequencies harmonise well together because of their simple relationship. Bird song can be described musically, and is pleasant to our ears. Other animal sounds and human languages are more complicated, but can be detected and learnt for communication.

Noise does not sound so pleasant as music because it contains a mixture of many unrelated frequencies which have no pattern that our brains can identify.

Loudness is measured (on a non-linear, logarithmic scale) in units called decibels (dB). We can detect whispers of 20 decibels and tolerate loud sounds up to 100 decibels, but above that level a human ear may be damaged. So some workers wear ear- muffs to protect the ears.

Your task:

- investigate the variety of sounds produced in nature, music and technology
- conduct a survey in your school of different kinds of sounds students like and dislike
- suggest (and if possible test) limits for acceptable sound frequencies and levels
- make a tape-recording of some sounds and ask people to try and identify them
- record your observations carefully in a table or chart and interpret the results
- in a formal debate, argue a case, for or against, the motion that "everyone should have freedom to enjoy music as loudly as they wish"
- you may wish to inform the community about your findings

Follow-up activities

- prepare a display of traditional and modern musical instruments
- prepare and display an informative poster about reducing sound pollution
- develop a role play / dramatisation / dialogue on good and bad effects of sound

Preparations for this activity includes the following :

Ask students to make a collection of musical instruments, drums, cassette-tapes and other sound devices such as buzzers, bells, vibrators, whistles, rattles, loudspeakers, etc.
At least one cassette tape recorder with a microphone will be required.

Background information

Table 1 Frequencies of sounds made & detected by humans and some animals

Source	Sound frequencies made	Frequencies heard
People	80 up to 1100 hertz (bass - 82 to 294 hertz alto - 196 to 698 hertz)	20 hertz up to 20 kHz
Elephant	10 hertz up to 15kHz	5 hertz upwards
Dog	450 up to 1000 hertz	15 hertz up to 50 kHz
Frog	50 hertz up to 8 kHz	50 hertz up to 8kHz
Sparrow	2 kHz up to 13 kHz	250 hertz to 21 kHz
Grasshopper	7kHz up to 100 kHz	100 hertz to 15 kHz
Bat	10 kHz up to 120 kHz	1 kHz up to 120 kHz
Piano	27.5 up to 4186 herts	
Guitar	82.4 up to 698 hertz	
Trumpet	165 up to 932 hertz	
Flute	262 up to 2092 hertz	
Telephone	Limited range - so voice may seem distorted	
Loudspeaker	depends on quality , also range of amplifier	

Table 2 Loudness of some sounds

Sound	decibels
Threshold	0
Leaf falling to ground	10
Very soft whisper	20
Mosquito buzzing	30
Small bird singing	40
Talking normally	50
Telephone ringing	60
Talking loudly	70
Loud car radio	80
Inside a noisy bus	90
Baby crying loudly	100
Pop/rock music group	110
Jet taking off (50m)	120
PAINFUL	130
EAR DAMAGE	140

The basic Nepali musical scale for harmonium is sha, re, ga, ma, pa, dha, ni, sha while the western scale runs middle C (256 hz), D, E, F, G, A, B, top C' (512 hz). The human lower threshold of hearing is 10^{-12} watt-m^{-2}. The loudness (dB) scale is logarithmic (non-linear).

Teaching strategy

Class and group discussion of varieties of sounds sources
School survey of sounds which students like and dislike most
Group experiments to investigate some instruments and test responses to different sounds
A formal debate for or against personal freedom to play loud music
Preparation of information about how to reduce sound pollution.

Achieving and Assessing the Objectives

These activities may best be assessed formatively, by observing individual participation in the group activities, rather than summatively, but there are opportunities to set descriptive or creative written assignments during and after the project, and to check the extent to which students appreciate the factors affecting and reducing sound pollution.

Objective	Activities to achieve this	Assessment procedure
Investigate various sounds produced in nature, music and technology	Produce sounds by various menas and compare them	Written or oral report of the experiments and examples studied
Survey of the sounds other students like and dislike in different circumstances	Interviews	Written or oral report of the survey
Develop and test a theory concerning acceptable sound levels	Brain-storming in group to produce a theory and testing responses to various sounds	Written or oral statement and report of findings
Awareness of individual responsibilites concerning reduction of sound pollution	A debate that "everyone should have freedom to enjoy very loud music"	Written prepared argument for or against the motion
Communicate results in an appropriate form for the benefit of others	Develop information in form of a handout or poster	Outcomes of the survey, experiments and report
Cooperate and participate as a member of a group	Participation in corporate activities of the group	Involvement , interest and cooperation evident

Authorship

This unit was developed by

Dr Sharada D Maharjan CLEST and

Patrick A Whittle ICASE

Unit 4 Pineapple Shaped Waste Bins

An investigative experimental study

Introduction

This unit focuses the attention of students on the problem of disposal of waste materials from domestic activities. They are required to suggest the best possible site for dumping different kinds of waste and how to neutralise, recycle or use some of these domestic waste materials. It provides opportunity for carrying out a local experimental investigation which has strong environmental, technological and sociological components for the proper disposal of waste. It can also promote creativite thinking among the students and help to develop the habit of being more responsible in their society.

Educational Aims

The purpose of this unit is to expose students to the following opportunities:

1. Identifying and testing biodegradable and non-biodegradable waste materials
2. Suggesting practical waste collection procedures in the community
3. Suggesting environmentally friendly waste disposal methods
4. Initiating ideas of recycling materials of use in the community
5. Cooperating as a member of small community task force
6. Communicate waste disposal proposals to the community

Scientific concepts involved:

Biodegradable and non-biodegradable wastes metals plastics recycling
energy conservation compost/organic fertiliser pollution dumping site
microorganisms anaerobic decomposition methane biogas digester

Teaching / learning activities suggested:

Class discussion and group discussion of waste disposal problems
Community survey of the range of domestic and industrial waste materials
Planning, conducting and reporting investigative experiments and tests
Developments of suitable handouts or posters for use in school and community

Teaching / learning resources required:

Organic domestic wastes (eg banana skin, orange peel, vegetables, food remnants.....)
Inorganic domestic waste (e.g. glass, metal cans, plastic bags, polystyrene, car parts....)
Twenty or more flowerpots (or hammer and nails)
Digging tools, watering cans, large collection containers, paintbrushes, paint

Background information:

Different kinds of wastes are produced during various household activities. These may not cause serious problems of disposal of wastes in the rural areas, but they have been a great problem in the urban areas, especially Kathmandu valley. If piles of garbage are left in the business centres or residential areas they cause nuisance, attract insects and stray animals and create an offensive atmosphere. Due to biological and chemical decomposition, gases are produced with noxious smells. The rubbish can be a major source of various diseases.

This is a problem of pollution by improper disposal of solid waste. Although waste collection containers may be provided, and emptied regularly, the contents must still be disposed of. Illiterate people may not be able to read the "Use Me" signs or other notices on waste-bins. The idea of pineapple-shaped waste-bins is that these identify receptacles for organic waste. Waste-paper bins could have a picture of a pen and writing paper on it.

When national and local authorities make provision for waste disposal they may meet strong opposition by the people who live around the dumping sites. Why do you think they oppose the sites ? Is it possible to select sites away from residential areas ? Are rivers and gulleys suitable for that ? What could be the best possible type of dumping site with the minimum adverse effects on people (and the other living animals and plants) of that environment ?

Your task:

- collect and carry out tests to identify biodegradable and non-biodegradable materials
- identify waste materials which could be usefully recycled in the community
- propose diffferent receptacles for collecting different kinds of waste materials
- suggest ways of disposing of combustible, biodegradable and non-degradable waste
- develop a public relations plan to target the community about proper waste disposal

Follow-up activities

- prepare and display a poster report of your findings and proposals
- introduce a waste-disposal systerm in your school
- develop a role play / dramatisation / dialogue to communicate your findings
- attempt to make a biogas digester (long term project)

Student Resource Sheet Unit 4 Pineapple Shaped Waste Bins

[This includes long term experiments which may require several weeks]

Investigation I Classification of Domestic Waste Materials

Make a collection of (at least twenty) waste materials (if possible, 3 or 4 of each)
e.g. bags, packets, cans, bottles, newspapers, rags, rubbish, kitchen and garden waste.....
Identify and mark a secure outdoor area (e.g. roof) for your long-term tests
Secure one specimen of each in a labelled flowerpot (or nail them to the ground)
Observe the specimens every week, and record any changes.
Classify the materials according to how they degrade (change)

Investigation II Factors Affecting Decay of Waste Materials

From your collection of waste materials test each as follows:
a) try to burn a selection of materials b) bury a selection underground
c) place a selection in a shady, moist place d) expose a selection in direct sunlight
e) place a selection in open ground, keeping them wet by watering regularly.
Observe the specimens, recording any changes. Classify them according to how they degrade.
What is the optimum condition for the decay of waste ? Does the mass change after decay ?
Is there any value in those materials ?

Investigation III Re-using Waste Materials

On the basis of investigations I and II identify and tabulate materials which are
(i) biodegradable (ii) combustible (iii) non-biodegradable ,
and find out experimentally which of these materials can be useful in any ways.
Prepare a brief report summarising your findings about all these materials.

Setting up a Waste Disposal System

On the basis of your previous investigations, waste materials are of at least three types.
Obtain three containers and suitably identify them for different types of waste.
Place the receptacles at strategic locations in the school compound and arrange
a schedule of members of your waste disposal task force to empty them regularly,
disposing of the contents by burning, burying or re-cycling.

Follow-up activities

Investigate how biodegradable waste material can be used for
(a) making compost (natural fertiliser) by burying
(b) making biogas (methane) by anaerobic decomposition, in a digester.

Promote cleanliness and avoid pollution of your compound/community by means of
a waste disposal campaign or competition.

Teacher's guide: Unit 4 Pineapple Shaped Waste Bins

Background information

Most rubbish can be re-used (recycled) in some way or another - but this depends on its durability (e.g. old car tyres are often recycled for repairing shoes) or its degradability (e.g. combustible waste material can be burnt to release useful energy but the process may also emit undesirable fumes and gases).

Animal and plant waste may be degraded under suitable conditions (absence of oxygen, temperature between 20° C and 35° C, and presence of microorganisms). In this process the organic material is broken down and produces methane (biogas) and some other gases.

A biogas digester is a container into which biodegradable waste is deposited for production of methane gas (or biogas) for cooking, heating and lighting (without smoke), while the residual slurry, which is rich in nitrogen and phosphorus compounds, is used as fertiliser.

More commonly natural fertiliser (compost) is produced by decomposition when organic waste material is put in a covered pit, although the methane gas is not used.

Teaching strategy:

This is a long term activity which may be initiated in class, but continued as a project.

1. A class discussion of solid waste disposal issues initiates the collection of materials but it is advisable to identify a suitable place for bringing these (not the classroom).
2. In their own time, students conduct long-term tests on the materials
3. Students devise waste disposal system for the school
4. Students design and deploy (pineapple shaped ?) waste bins.
5. Students promote cleanliness of the compound/community by means of a waste disposal campaign or competition.

Waste Disposal Task Force

One of the expected outcomes is establishment of a **Waste Disposal Task Force** in your school , which may however require the approval of the headteacher or the cooperation of the School Management Committee.

Inter-Class Competition

You may also wish to consider organising an **Inter-Class Competition** for designing and producing the most attractive waste-bin.

Achieving and Assessing the Objectives

These activities may best be assessed formatively, by observing individual participation in the group activities, rather than summatively, but there are ample opportunities to set some descriptive or creative written work during and after the project, and to check the extent to which students are influencing waste disposal practices in their school.

Objective	Activities to achieve this	Assessment procedure
Identifying and testing biodegradable and non-biodegradable materials	Collecting and testing waste materials	Written or oral report of the classification and tests
Suggesting practical waste collection procedures in the community	Devising and installing waste collection bins in the school compound	Written or oral report with examples of the procedures
Suggesting environmentally friendly waste disposal methods	Group brain-storming	Written or oral action plan
Initiating ideas of recycling materials of use in the community	Collecting re-usable and recyclable materials and passing them on	Exhibition of recycled materials and poster display
Cooperating as a member of a school or community waste disposal task force	Collecting rubbish , designing waste bins and publicising disposal system	Written or oral report and other tangible evidence of effective campaign
Communicate waste disposal proposals to the school and community	Develop information in form of a handout or poster	Outcomes of the project in the form of a school waste disposal system

Authorship

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Unit 5 Safe, Clean Drinking Water

Survey and experiment-based decision-making study

Introduction

People in most villages and towns suffer from water borne diseases. Sometimes these diseases even become epidemic. Due to worms and other pathogenic organisms the health of children is particularly affected. The most common diseases are amoebic dysentery, cholera, diarrhoea, and round worms. Due to lack of education, awareness or health facilities, village people suffer unnecessarily from these diseases and their problems may become a matter of life and death. They are often unable to take precautionary measures or remedial action as they lack the appropriate knowledge. A supply of safe, clean drinking water could help solve their problems.

Educational Aims

The purpose of this script is to expose students to the following opportunities:

1. Identify properties of pure drinking water and distinguish it from polluted water
2. Apply scientific knowledge to detect impurities in water and purify water
3. Identify common water borne diseases in their community
4. Interview people/health workers to collect information about water borne diseases
5. Develop awareness in people of the need to avoid pollution and conserve clean water
6. Participate in solving problems of clean water supply in their own society

Scientific concepts involved:

potable / distilled water	contaminated water	mineral and soda water
separation of mixtures	chemical purification	evaporation/condensation
decantation	solar energy	pollution
microorganism	water borne diseases	preventative measures

Teaching / learning activities suggested:

Class discussion, group discussion, community survey, investigative experiments and tests
Reporting and developments of suitable handouts/ posters for use in school and community

Teaching / learning resources required:

Microscope	Safranine	pH paper	Filter paper/ funnel stand	
Testtubes	Bottles	Spirit lamp	Beaker	Thermometers
Nirmal tablets	Bleaching powder	Potasssium permanganate		Mineral water
Wooden box	Glass panes	Plastic pipe	Collecting vessel	Black paint

Background information

Pure water may be obtained by using solar energy to evaporate it, and then allowing it to condense in a "solar still" : one design of which is shown.

Solar purification of water

Water Tests	Requirements	Indications
Appearance	Handlens/ microscope	Microorganisms
Evaporation to dryness	Heating in spoon	Residue
pH test	Universal indicator paper	Acidity/alkalinity
Tests for ions	(various, at 10+2 level)	Dissolved salts

Your task:

- Identify different sources of water in your community
- Collect samples of water from different water sources and test them.
- Discuss in groups concerning the collected samples of water with reference to:
  -impurities observed in water samples through a naked eye/ under microscope
  - processing tests on water "purified" by decantation, filtration, distillation, tablets
  - experiments performed to compare water before and after solar distillation
  - the taste of mineral water, tap-water , distilled water, soda water ....
- Collect data in group by interviewing community people and local health workers
- Find out what type of water borne diseases may be common in the community.
- Investigate whether any disease is common in certain season or for the whole year
- Discuss in groups and generalise :
  - what might be the causes of diseases - can any be related to the drinking water ?
  - which types of contamination / germs / organisms could be in the water ?
  - properties of drinking water - possible alternatives to make water drinkable ?

Follow-up activities to alert the community

- Prepare and display a poster report, with tables / graphs / charts
- Develop a role play / dramatisation/ dialogue to communicate your findings

Preparation for this activity

Some students may be capable of constructing the solar still, or ask a carpenter to do it :
a. Make or adapt a wooden box with glass panes, top and front, as shown
b. Arrange the top glass pane sloping (about 15°) and so that it can be opened
c. Stand the front glass pane in a piece of pipe which is half-section lengthwise.
d. Keep the box slanting so as to allow the distilled water to flow for collection
e. Paint the sides of the box dull black, with blackboard paint
f. Place a shallow vessel containing impure water inside the box
g. Expose the complete set in direct sunlight and collect distilled water in a clean vessel

Students must be made aware that water coming from a pipe or tap may not be potable. Even water from a reliable source may easily be contaminated due to :
(a) chemical corrosion of the pipes, or from material lodged inside them
(b) leakage of surface water or waste fluids into water pipes running alongside waste pipes
(c) contamination at the outlet by the carelessness of people collecting water

Water Tests	Activity	Indications and inferences
Appearance	Use handlens / microscope	Solid matter, algae, organisms may be seen
Evaporation	Heat sample in spoon	Residue could be examined and tested...
pH test	Use indicator paper	Acidity or alkalinity -> further tests ?
Tests for ions	Test for metals / other ions	Dissolved salts -> where originating ?

The activities may indicate that water borne diseases could be a problem in the community. The most common diseases are : amoebic dysentery, cholera, diarrhoea, and round worms. Students can make inquiry, interview, investigate, discuss, and perform practical activities. From these they can draw conclusions and attempt to solve the local problems by applying scientific methods to their day-to-day life and for the benefit of their whole community.

Teaching strategy:

1. Begin class discussion with probing questions such as - What are local health problems ? What are common diseases and their causes ? Can we find out if water is a factor ?
2. Discuss the kind of informations needed - encourage testing water samples - collecting information from local people - assist development of interview questions
3. Discuss methods of presenting the scientific and sociological data acquired
4. Assign activities to the students in groups - collecting and testing samples of water, - purifying water by different methods - interviewing local people and health-workers
5. Discuss - requisites of pure drinking water - causes of problems associated with water - possible solution of the problems - preventative measures - sharing information.
6. Students prepare posters, dramas, to disseminate their findings.

Safety : Do not allow students to taste any water of uncertain source/purity

Achieving and Assessing the Objectives

These activities may best be assessed formatively, by observing individual participation in the group activities, rather than summatively, although there are opportunities to set some descriptive or creative written work during and after the project, and to check the extent to which they are able to relate cause and effect concerning contaminated water supplies.

Objective	Activities to achieve this	Assessment procedures
Compare properties of pure water and polluted water	Visual observation and chemical tests	Tabulated written report
Apply scientific techniques to detect impurities in water and to purify water	Use of microscope and chemical procedures	Written report including findings (drawings)
Identify common local water borne diseases	Interview	Accurately correlate diseases to their source
Collect information about water borne diseases	Interview and other local information collection	Display findings, with drawings
Make people aware of the need to avoid pollution and conserve clean water	Design poster or write a dramatic sketch	Poster or drama
Participate in solving local problems of water supply	Join in local activities	Involvement

Authorship

This unit was developed by

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Unit 6 The "Naulogaon Free Sweets" Story

A role-play, experiment-based, decision-making case-study

Introduction

Water pollution is a serious problem in Nepal and in this activity students are asked to adopt the roles of some children and other residents of a village called Naulogaun. After hearing their story the teacher leads them to carry out tests on river water, to discuss their findings, draw conclusions and make recommendations for improving the health of their community.

Educational Aims

The purpose of this unit is to expose students to the following opportunities to :

1. Develop awareness of the role individuals can play in their society
2. Encourage the use of their scientific knowledge and skill in solving community problems
3. Appreciate the ways groups can co-operate to solve problems in the community by collecting scientific evidence and applying rational thought.
4. Discuss and relate scientific information to their community, communicate orally and reach co-operative group decisions about necessary action.
5. Develop awareness of the factors affecting the quality of drinking water and the need to promote good community practices in the use and protection of water sources.

Scientific concepts involved

People and environment	industrial effluent	residue, acidity
contamination/pollution	water borne diseases	symptoms
purification	chemical analysis	standardised tests.

Teaching/learning activities suggested :

This unit starts with a dramatised role-play of a scene in a school near a river - Part I
Students next carry out tests (simulating tests on the water samples in the story - Part II
Students can make a large map and/or model of the village area.
Students discuss the results of the tests in a community role-play dramatisation - Part III

Teaching/learning resources required :

Role-play script, with map of the sugar mill locality.
Three buckets of water samples (prepared as inidicated in teacher's notes)
Thermometers , Universal indicator paper, Clinistix (or similar)
Microscope, hand lens , test tubes, filter papers, funnels, beakers

Background information

The Scenario

The five characters in Part I of this story which begins in the school are:
Anil and Bindu, who live at Naulogaon and attend Naulogaon m.v.
Chameli and Danbahadur, who live at Puranogaon, and also attend Naulogaon school.
Miss Lalita is their science teacher.
You have a plan of Naulogaon (draw your own picture or make a model of it).

For Part III of the story, the following characters will also be needed :
Dr Rama, who visits the Naulogaon Health Centre every week.
Mr Napha, who is the Manager of the Naulogaon sugar factory.
Mr Keshab, who is the Chairman of the Naulogaon Village Development Committee.
Various other residents of Naulogaon can be added -
parents, farmers, shopkeepers, policeman, harmacist, nurse, factory workers, drivers, ...

Your task:

- Dramatise Part I of the story
- for Part II, check the given water samples for appearance / colour / suspended matter
  test for (a) temperature (b) pH - use indicator (c) sugar - use clinistix
  (d) microscopic organisms - use microscope
- look at the map and discuss possible explanations for
  (a) the "Free Sweets" and (b) the village health problems.
- dramatise Part III of the story, when, after testing the water,
  the teacher asks the VDC chairman to arrange a public meeting between herself,
  the doctor, factory manager and the village people (with the 4 students present)
  to discuss the problem and try to find a solution.
- You will have to decide who is Anil, Bindu, Chameli, Danbahadur , Ms Lalita,
  the VDC Chairman, doctor, pharmacist, factory manager, factory workers,
  policeman, shopkeeper, fisherman, washerman, market seller, farmers.....
- You all need to think about what YOU will say at the meeting.

Follow-up activities

For follow-up you will be asked to write an account of what should happen next
to make the results of the meeting known in the whole Naulogaon community.

Identify causes of water pollution in your own locality - these may be
agricultural, commercial, domestic, industrial and others...

Student Resource Sheet Unit 6 The Naulogaon Free Sweets Story

Part I of the story

Anil: I was not able to come to school last week.
I could not go swimming near the river bridge with my friend Bindu.
I had headache and was suffering from bad diarrhoea. I still feel quite unwell.

Ms Lalita: Bindu missed school this week too.
Her brother says she also has diarrhoea and headache
Both of you should go to the clinic for a check-up.
Did any of your friends have similar symptoms ?

Chameli: Sorry you have to go to the clinic, Anil.
Dan and I are going swimming in the water-fall up the river today.
But we are sure will not get Free Sweets like you and Bindu !

Ms Lalita: What ? Chameli, what do you mean by Free Sweets?

Anil: Miss, we found the river water near the bridge is very sweet.
After swimming we take some home in a bottle, for drinking.
Our mother uses it for making tea and for preparing jilabi.
She has stopped buying sugar these days.

Ms Lalita: How wonderful ! I think that is very interesting.
I wonder how the water from the waterfall and bridge differ ?
Perhaps you could each bring a bottle of water from three places in the river
and we will do some tests on them.

Danbdr: Miss, I think the water near the bridge is dirty.
I have seen some of the factory workers going to relieve themselves down there.

Ms Lalita: Don't jump to conclusions, Dan !
We must be scientific about this and base our conclusions on the evidence.

Part II of the Story : testing three samples of water from the river

Part III of the Story

The characters include Anil, Bindu, Chameli, Danbahadur, Ms Lalita, Dr Rama (clinic) Mr Napha (factory manager) Mr Keshab (VDC Chairman), policeman parents, farmers, fishermen, shopkeepers, market sellers, pharmacist, nurse, factory workers, drivers, ...

Part III of the story.....

This depends on whatever you yourselves make up !

The Naulogaon District

Background information

Sugar : Sugar cane contains disaccharides such as glucose and fructose, $(C_6 H_{12} O_6)n$ which form the monosaccharide sucrose. This is extracted in the sap from the raw cane by crushing in mills, that use considerable energy from which some heat is lost.The liquid extract is purified for use industrially, or made into sugar by crystallisation, while the solid waste material is often used as animal fodder. Some remaining liquid waste has to be disposed of.If concentrated liquid sugar waste extract finds its way into moderately warm water it will form an excellent nutrient solution for bacterial growth.

Bacterial diseases : Bacteria are the smallest organisms having a cellular structure which occur everywhere in soil, dust, water, air, in an on animals and plants. Common bacterial water-borne diseases include cholera, typhoid and dysentery which may be contracted from water contaminated by infected food or faeces. These diseases can be prevented or eliminated by clean habits, using safe underground water, or protected or treated surface water supplies.

Teaching strategy

It is important to prepare the three buckets of "water samples" just before the lesson:

Water from upstream Cool temperature, 10° C Clean	**Water from under bridge** Warm temperature, 30 ° C Cloudy, suspended particles (tea leaves), dissolved sugar	**Water from downstream** Slightly warm, 20 ° C Cloudy, dissolved sugar, Particles, algae, if possible

The teacher tells Part I of the free sweet story and allocates the key roles to the students. Student from the class adopt roles of the characters in Part I , and simulate the discussion. Students carry out experiments to test the three buckets of prepared water (Part II). Later students will adopt other roles for Part III, e.g. shopkeeper, farmers, pharmacist - and simulate their discussion .The chairman of this meeting may be the teacher or a very capable student. He or she will need to summarise the outcomes of the meeting and emphasise what action should be taken by the community.

What to do about the problem?

The students discuss, or write their ideas, about what should happen next in the community. Afterwards the teacher highlights the most interesting suggestions and similar issues which occur in their actual community, to reinforce the most desirable environmental attitudes.

The students or members of the community could be encouraged to re-interpret the story in the form of a dramatic local street theatre production.

Achieving and Assessing the Objectives

Formative assessment of individua1 student progress can be made by observing their involvement and attitudes while simulating the discussions , testing the water samples, interaction / discussion / participation in group activities. Students should show concern and awareness regarding water pollution, its prevention and control measures. They are expected to show interest in disseminating this knowledge and concerns in community.
It is not easy to ascertain the extent to which the aims of this unit have been attained.
The means of achievement is chiefly through role-play simulation activities.
Some written assessment is however possible as shown below.

Objective	Activities to acheive this	Assessment procedures
Awareness of the role educated individuals can play in a developing technologicial society	Case studies and / or simulation activities about science and technology in society	Write a story about science in the life of (e.g.) market vendor, shoe repairer, or petrol pump attendant.....
Ability to use scientific knowledge and skills to solve local problems	Practice in applying knowledge and skills in simulation activity	Answer structured questions about local problem situations
Appreciation of how to collaboratively solve a problem using scientific evidence and arguments	Group discussion, debates and other activities to come to an agreed consensus about a course of action	Given scientific data, select, use and apply it to solve a problem in a simulated or real-life situation
Relate scientific facts for community decisions about necessary actions	Group discussions and development of community information tactics	Produce effective information posters, leaflets or action plans
Awareness of factors affecting drinking water and need for protection of water sources	Group discussion, case study and simulation activities	Write an essay about methods of prevention of water pollution

Authorship

This unit was developed by

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Unit 7 What Food Do You Like Best ?

An experiment-based project activity

Introduction

Fake commodities are very common in South Asian markets these days. Most people find it very difficult to know the quality of something if it is labelled or looks very much like the real one and so they end up paying a higher price for poorer standard clothes, spare parts, and even food. Adulteration is the name given to making something poorer by adding another cheap substance. It is a big problem for consumers who may not be able to identify the material until it is too late. Adulteration of food is the most serious problem as it has a direct effect on the health of people. In many cases using adulterated food can be fatal. Some of the cases of food poisoning which are reported are due to negligence but others are the result of adulterated food. This unit introduces students to a project in which they examine the quality of three (or more) different food materials, develop knowledge about testing procedures and reliability and gain greater awareness of the prevalence of food adulteration, with risks involved for the general population.

Educational Aims

The purpose of this unit is to expose students to the following opportunities :

1. Developing knowledge about how adulterated food can affect their health
2. Devising tests for different food items, their ingredients, colouring and flavouring
3. Testing various food items, separate and test some of the ingredients
4. Conducting experiments to test purity of various foods and identify adulterated ones
6. Participating, discussing and cooperating as a member of a group
7. Oral and written reporting and/or other means of communication to others
8. Developing awareness of the value of good food for health

Scientific concepts involved

Decantation	distillation	chemical reactions	concentration
Economic advantage	lactometer	natural & synthetic compounds (dyes, flavours)	
Neutralisation	precipitation	purity and quality	nutrition

Teaching / learning activities suggested:

Class discussion, group discussion, group investigative experiments and tests
Group reporting and development of warning handouts/posters for use in school

Teaching /learning resources required :

Common foods (10 g each) [some may be deliberately contaminated] such as : ghee, milk, cooking oil, rice, pulses, sweets.... sieves (different mesh) lactometer beakers test tubes glass rod glass plate wooden plate conc. HCl, conc. HNO_3

Background information

Food is essential for sustaining life, but it is important to know the quality of the food we take. Many varieties of food are imported into or produced in Nepal these days. Periodical checking for the quality of food on sale in the market is carried out be Government inspectors so that people may not suffer from food poisoning or other negative effects of taking poor quality food.

Adulteration is the name for making something poorer by adding some other cheap substance.

Adulterated food is the most serious problem as it has a direct effect on the health of people. In many cases using adulterated food can be fatal. Some of the cases of food poisoning which are reported are due to negligence but others are the result of adulteration. Unfortunately, adulteration of food is common. Some examples are given in the resource sheets and include: diluting milk with water, mixing stones in rice, adding mud in mustard seeds, mixing inferior quality oil in cooking oils, adding toxic khesari dal to pulses, and even dyeing vegetables

For most people it is impossible to distinguish fake from real items, or poor from good ones, so students with scientific knowledge can warn them of risks and help them avoid being cheated.

Your task:

- Discuss in your group examples of cheating you have met in the market
  (Suggest methods of separating rice from stone, and mustard seeds from mud)
- Check the appearance of the given food samples for their colour, odour, purity, etc.
- Discuss further tests which may be necessary on the purity of these foods
  (some of these tests may not be possible in school, but others are)
- Perform any available experiments to further test the quality of these items
  (details of some tests on ghee, milk and cooking are provided)
- Discuss in your group whether these tests are conclusive
- Discuss and write down your conclusions from the results of your experiments
- Compare your findings with newspaper reports (see Resource Sheets)
- Suggest ways of warning people against adulterated food.

Follow-up activities to alert the community

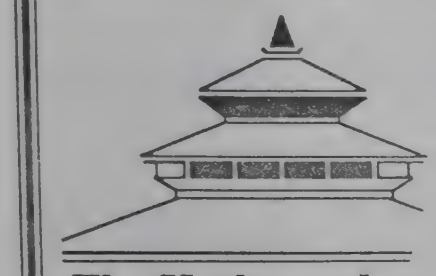
- Prepare and display a poster report, with tables / graphs / charts

- Develop a role play / dramatisation / dialogue to communicate your findings.

Merchants of Death

evel of Cholestrol is a me now. At least, I'm not d about the damn ated oil!!

not man. This brand of oil nless. Don't you know sing it for years?!



The Kathmandu

The deadly poison that the enemies mix in the food, drinking water or administer it in the raw fruits, the same do I remove
- Atharva Veda

Validity of mustard oil tests questioned

By a Post Reporter

KATHMANDU, Sept 8 - After the Ministry of Agriculture declared that it found traces of *argemone mexicana* in some of the sample oil it tested, food technologists today questioned the Central Food Research Laboratory's (CFRL) technological competence to

Citing test results released by the Central Food Research Laboratory, the Association said anywhere between 30 to 50 percent of the samples were not safe.

in adulteration ...
Talking to ... Meet Your Secret ... programme today, Dr. Puran ... Shrestha, an expert on food ... testing of ... oil ... extensive process that can be done in a short period ... technol... CFRL carry ... detecti... Mi...

Merchants of death

Reports that since the last few days traders have been marketing adulterated mustard oil ... caused havoc in Ind... grave cons...

NEWSLINE

Quality of mustard oil

KATHMANDU, Sept 9 (RSS) - Minister for Agriculture Trilochan Sharma Dhakal said at the House of Representatives today that the Ministry of Agriculture, the Central Food Research Laboratory and the five regional food laboratories under it have been actively mobiliz... in maintaining the quality of mustard oil available in the market. ... unfounded. ... seen how effectively ...norities police the ... deter the merchants of spreading terror in t... market in the run up ... season of Dashain.

Adulterated mustard seeds confiscated

Mahendranagar, Sept 4 (RSS):

Three of the four Indian trucks carrying adulterated mustard seed from Bansdiv... India to Dhangadhi ... Kanchanpur district have ... confiscated by the Gulariya Police Post, according to Chief District Officer Thaneswore Devkota.

The trucks carrying about 300 bags of adulterated mustard to the oil mill of Dugad was confiscated at the order of the District Administration Office

Retailers not to sell oil if not certified

38 tins of cooking oil ized in Biratnagar

'30-50 percent oil brands not safe'

PRESS RELEASE

Food Products Widely Adulterated !

Do you go by bright colours while choosing vegetables and sweets ?
If yes, think twice.
Researchers at Central food Investigation Centre (CFIC) warn that attractive sweets, vegetables and other food products may cost you your health.
Reason: Farmers spray pesticides to save vegetables from decaying and use colours to make food products look bright. According to researchers at CFIC, powdered brick is mixed in chilli powder, saw dust in cumin and coriander powders and other hazardous powders in turmeric.

Milk samples tested in the capital are found to be highly adulterated and of low quality. Especially milk is found to be heavily thinned with water and powder milk added liberally to thicken it.
A CFIC spokesman says that the "pasteurised milk" available in the market is often not pasteurised. If Nepali people did not have the practice of boiling their milk. gastroenteritis would have reached epidemic proportions.
Many dairies are in court for selling low quality milk. In CFIC sample tests of food products, milk is usually the second most commonly adulterated item.

Vanaspati ghee is also found to be heavily adulterated in the country.
Researchers believe there is a need to test vanaspati ghee in the same way that edible oil is being tested at present. It is expected that a standard for vanaspati ghee will be introduced soon.

Likewise, local noodles may be adulterated with inedible products: the kind of metallic yellow used can even activate cancer.
One should eat only plain colourless noodles.

The Food Act is mostly only applied in the capital, although it could be implemented in 36 districts, including the Terai, where adulteration is a serious problem.
CFIC has to go to the District Administrative Office to file a case if a food product is found to be defective and this slows down the process of prosecuting offenders.

This report appeared in Kathmandu newspapers in October, 1998

Looking for impurities in food materials

1. Testing the quality of ghee

a) Melt one teaspoonful of ghee in a test tube.
b) Add an equal amount of conc. HCl and a pinch of common salt.
c) Shake well for about 1 minute and allow the tube to stand for 1 minute
d) Crimson colour appearing in lower layer shows vanaspati (vegetable) is present in the ghee

2. Verifying the purity of milk

a) Put a drop of milk on a vertically held glass plate.
Pure milk would stay on , flow very slowly, leaving a white mark behind.
Diluted milk would flow quickly without leaving any mark
b) Use a lactometer or hydrometer to measure the specific gravity of the milk sample
When the lactometer or hydrometer is floating in the sample, pure milk will give a reading of at least 1.026. In diluted milk the instrument goes down lower.

3. Checking the quality of cooking oil

a) Add a few drops of conc. HNO_3 to the sample of oil and shake well.
b) Observe the colour of the acid level
c) A red or reddish brown colour indicates the presence of argemone oil.

4. Testing for metanil yellow in Dal

a) Shake 5 gms of dal sample with 5ml of water.
b)Add a few drops of HCl
c) Pink colour can indicates the presence of metanil yellow

5. Testing other commodities

You may like to suggest good ideas for ways of checking other food and commodities or means of purifying them or separating contaminated mixtures. Try these tests out.

Follow-up activities

6. Design a Poster or Write a Play

- Prepare and display a poster report of your tests with tables / graphs / charts
- Develop a case-study, role play, dramatisation or dialogue in order to effectively communicate your findings as a warning to others.

Background information on fats, oils and waxes

Fats, oils and waxes are materials that do not mix readily with water. Edible oils are directly obtained from plant and animal sources. They are mixtures of many different organic molecules called Lipids. The most common component of each edible fat or oil are Triacylglycerols commonly called Triglycerides. Fats and waxes are solid or semi-solid at normal room temperature, while an oil remains liquid. Most waxes are inedible fatty-acid esters .
The major sources of edible fats and oils are :

Treecrops - coconut, palm, palm kernel, olive ;
Oil seed crops - soyabean, rape seed, mustard seed, sunflower seed ;
Fish/live-stock - fish oils ; animal fats, butter.

Fat is an essential dietary requirement which has a major role to play in a balanced diet. Fats have a high energy density. The human body uses fats as energy storage materials and they also provide some of the body structure. However, excess fat in the diet can result in dangerously high levels of cholesterol in the blood, resulting in heart failure. For this reason some people prefer to use polyunsaturated spreads derived from sunflower oil instead of butter on their bread.

Non-edible mineral oils originate as crude oil (petroleum) mixtures of alkanes, alkenes and arene hydrocarbons, which are separated into purer constituents such as butane and propane fuel gases, aircraft fuel, petrol and diesel fuels, white spirit, kerosine, candle wax and bitumen.
Ingestion of small quantities of mineral oils can result in dropsy and, if untreated, death.

Fats and oils can best be analysed by chromatography, titration and spectroscopy but there are some basic experiments on the chemical properties of oils, which can be carried out in school laboratories, including isolation of sunflower oil and saponification.

Teaching strategy

1. Introduce the topic with a very general group discussion about cheating in the market. Have you ever been cheated ? What tricks do traders use ? What are the effects ?
2. Groups report back in a teacher-led class discussion, which should be brought to focus on the the particular problem of the quality of food and human health.
3. The teacher next initiates group discussions on the factors considered when purchasing
   (a) ready-to-eat food (fruits, nuts, sweets, cakes, samousas, bread, curd.....)
   (b) food for preparation and cooking (vegetables, rice, sugar, spices, oil.....)
   Discuss. appearance, cleanliness, freshness, taste, quality, and the need for controls.
4. Students are then introduced to the worksheet and asked to complete their group project reports which will contain the result of one or more experimental test.
5. A final class discussion is arranged to debate effects of food adulteration.
6. Encourage students to make known the health hazards from poor quality food and the means of reducing these risks through dramatisation, poster display or any other suitable communication technique.

Achieving and Assessing the Objectives

Some formative assessment may be made of individual student's involvement in each group giving opinions, putting forward some plan for testing, suggesting possible adulterants, carrying out tests, co-operating and communicating by different ways and means

Objective	Activities to achieve this	Assessment procedures
Knowledge about how adulterated food can affect their health	Inquiry, research, private reading	Short answer test or written essay
Devise tests for different food items, ingredients, colouring and flavouring	Match suitable tests for different items	Submit plan for testing food items
Test various food items, separate and test some of the ingredients	Follow instructions on handout to satisfactorily conduct tests	Report on results of tests on food items
Conduct experiments on purity of foods to identify adulterated ones	Compare properties of pure and adulterated food samples	Report satisfactorily on samples tested
Participate, discuss, cooperate as a member of a group	Corporate group activities	Peer comment and group reporting
Communicating to others the importance of food quality	Prepare poster or dramatic presentation	Effectiveness of poster or dramatisation as judged by outsider
Awareness of the value of good quality food for personal health	Whole project is directed towards this goal	Values/priorities indicated by short answer test, essay or in real life situations

Authorship

This unit was developed by

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Unit 8 Which Fertiliser Shall We Use ?
An investigative experimental study

Introduction

This unit focuses on different types of fertilizers which are available to use to increase yield of agricultural products by suppling required nutrient compounds of N, P, K, etc. The utility or effectiveness of fertilizers may depend on the variety of plants and various factors such as the length of time for plant uptake, and undesirable side effects as well as. The percentage of nutrient content and solubility. However in this unit we will assume that chemical fertilizers can be selected mainly on the basis of percentage content of nutrients and solubility.

Educational Aims

The purpose of this unit is to expose students to the following opportunities:

1. Awareness of advantages and disadvantages of different fertilizer for agricutural products
2. Conduct experiments on various fertilizers to establish their percentage composition
3. Conduct experiments on various fertilizers to establish their solubility
4. identify suitable fertilizers for use in growing different plants
5. investigate effects and impact of using the fertilizers
6. cooperating as a member of group
7. communicate orally or in writing to the community about proper use of fertilizers.

Scientific concepts involved:

agricultural product growing season artificial, natural and organic fertilizers compost
Percentage composition by weight potassium, nitrates , phosphates, sulphates
Nitrogen fixation plant uptake of nutrients solubility growth hormones

Teaching / learning activities suggested:

Class discussion and group discussion on identification and local use of fertilizers
Community survey of the range and types of fertilizers in use and their impact
Planning, conducting and reporting investigative experiments and tests

Student's Guide Unit 8 Which Fertiliser Shall We Use ?

Background information:

Fertilizers are the organic or inorganic substances that increase the fertility of the soil by providing (replacing) major elements such as N, P, K, Ca which are required by plants. Organic fertilizers are natural sources of plants nutrients which are prepared by burning or decaying organic remains of animals, dung, garbage, bone meal, ashes or compost. Animal and plant waste may be degraded under suitable conditions (absence of oxygen, a temperature between 20^{o} C and 35^{o} C, and in the presence of suitable micro-organisms). In this process the organic material is broken down and produces methane (CH_4 or biogas) and some other gases. More commonly, natural fertiliser (compost) is produced by decomposition when organic waste is put in a covered pit, although the methane gas is not used. Chemical fertilizers include urea (carbamide), potash, ammonium sulphate, ammonium nitrate, calcium nitrate, potassium phosphate, which are all imported into Nepal Animal manure was the traditional fertiliser which helped produce top soil containing humus - a dark colloidal material derived from decomposing matter. Most naturally fertile soils are rich in humus (of which 15% is made up of necessary air and water) as well as essential minerals.

What will be the effect of adding only chemical fertilizers to poor soil ? As only part of the fertilizers are taken up by plants, and as they are soluble, rain may wash them into streams and rivers. Can you identify any possible adverse effects on people, and the other living animals and plants in the environment, which could result from using these chemical ?

Your tasks:

- Make a survey to identify the types fertilizers used in the locality
- Make a community survey of which crops benefit most from these fertilizers
- In groups plan a series of inquiries and/or investigative experiments and tests
- Find out the percentage composition of some of the fertilizers
- Investigate the relative solubilities of different fertilizers
- Establish whether there are any relative advantages or disadvantages between using chemical fertilizers and using natural organic fertilizers
- Report the outcomes of your project activities
- Develop suitable handouts or posters to inform the school or community about some important issues concerning choice and use of fertilizers.

Follow-up activities (long term projects)

- conduct some controlled field tests of the effect of different fertilizers (on similar crops)

- make a compost pit or a biogas digester to use organic waste

Background information

Fertilizers are the organic or inorganic substances that increase the fertility of the soil by providing (replacing) major elements such as N, P, K, Ca which are required by plants.

Nitrogen is needed for stems, leaves protein, chlorophyll	Phosphorus is needed for root growth, fast ripening of crops and in energy exchange	Potassium is needed for production of flowers and quality and quality of fruits	Calcium improves soil by neutralising acids and improving water retention qualities	Humus aerates soil for bacteria and hold water need to transport the salts

Organic fertilizers are natural sources of plants' nutrients which are prepared by burning or from decaying organic remains of animals, dung, garbage, bone meal, ashes or compost. Animal and plant waste may be degraded under suitable conditions (absence of oxygen, temperature between 20°C and 35°C, and in the presence of suitable micro-organisms). In this process the organic material is broken down and produces methane (biogas) and some other gases. More commonly natural fertiliser (compost) is produced by decomposition when organic waste material is put into a covered pit, although the methane gas is not often used. Chemical fertilizers such as urea, potash, ammonium sulphate, are imported from countries with necessary technology and electrical power for a chemical industry (e.g. Haber Process).

Ammonium sulphate $(NH_4)_2SO_4$	Ammonium nitrate NH_4NO_3	Calcium nitrate $Ca(NO_3)_2$	Urea (carbamide) $CO(NH_3)_2$	Potassium phosphate K_2PO_4

If animal manure, which was traditionally used as a fertiliser, is replaced by chemical N,P,K substitutes the soil will not benefit from the aerating and water holding properties of humus. Most fertile soils are rich in both humus (holding 15% air and water) and essential minerals.

Teaching strategy:

Class discussion and group discussion on identification and local use of fertilizers
Community survey of the range and types of fertilizers in use and their impact
Divide the class into different groups for different activities
Planning inquiries and/or investigative experiments and tests
Collecting information about and conducting tests on fertilisers
Reporting outcomes of the project activities
Developments of suitable handouts or posters for use in school and community

Follow-up activities (long term)

Comparative field tests of the effectiveness of different fertilizers may be conducted and a compost pit dug to prepare and test organic fertilizer made from waste.

Achieving and Assessing the Objectives

These activities may be assessed both formatively and summatively by observing individual participation in the group activities and from reports of the chemical tests carried out. More descriptive or creative written work may also be set during and after the project.

Objective	Activities to achieve this	Assessment procedure
Awareness of advantages and disadvantages of different fertilizers.	User and supplier survey	Written or oral report of the classification and tests
Conduct tests on various fertilizers to establish their percentage composition	Inquiry and/or laboratory tests	Written or oral report with examples of the procedures
Conduct experiments on various fertilizers to establish their solubility	Laboratory solubility tests	Written or oral action plan
Identify suitable fertilizers for use in growing different plants	Survey, inquiry and/or field tests	Written or oral report
Investigate effects and impact of using the various fertilizers	Survey, inquiry and/or field tests	Written or oral report
Cooperating as a member of a group	Group project work	Participation, showing leadership or team membership skills
Communicate information about optimum use of fertilisers to the community	Develop information in form of a handout or poster	Effective communication to the community

Authorship

This unit was developed by

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Jeevan Hari Shrestha SEDEC, Sanothimi, Bhaktapur

Bal Krishna Vaidya Budhanilkantha High School

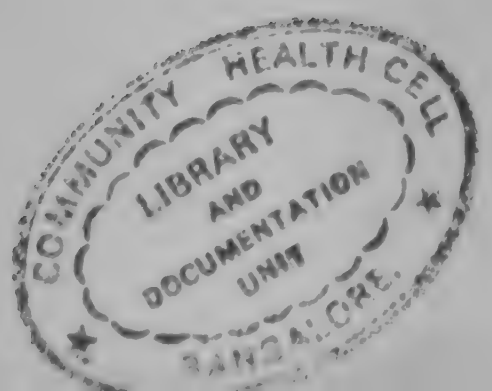
PROMOTING STUDENTS'
SCIENTIFIC AND TECHNOLOGICAL THINKING
- DEVELOPING SKILLS AND ATTITUDES
CONCERNING OUR ENVIRONMENT

APPENDICES

I. STL AND PROJECT 2000+

II. EVALUATION OF STL UNITS

III. REFERENCES



Appendix I Project 2000+ and STL in Asia

The Origins of Project 2000+

In 1990 the World Conference on Education for All recognised within its Framework for Action to Meet Basic Learning Needs an urgent need for a world community of scientifically and technologically literate citizens. That framework emphasised the importance of transmitting common cultural and moral values as well as laying a foundation for lifelong learning. In 1992 the Rio conference on Environment and Development expressed its concerns for the environment and quality of life in the "Education, Awareness and Training" document..

Project 2000+ was initiated to promote and guide the implementation of the scientific and technological dimension of Education for All with the goal of achieving responsible and sustainable development. The project is based on a partnership between a group of major intergovernmental and non-governmental organisations, with a steering committee consisting of representatives of the Commonwealth Secretariat, GASAT, ICASE, ICSU, IOSTE, UNDP, UNEP, UNESCO, UNICEF, WOCATE and the World Bank.

What is Project 2000+

Project 2000+ is not a project in the normal sense. Although it was initiated by ICASE and UNESCO, it has no actual ownership, funding nor specific pathways. It is intended to be owned by all who seek to promote its goals. In 1993, when an international forum of science educators met in Paris to launch Project 2000+, the Director-General of UNESCO said "In a world increasingly shaped by science and technology, scientific and technological literacy is a universal requirement if people are not to be alienated in some degree from the society in which they live...."

That forum made a declaration calling upon governments, industry, public and private interests, education authorities, NGOs and inter-governmental organisations to **work together in partnership to promote scientific and technological literacy** so that by the year AD 2001 appropriate structures and activities should be in place to foster scientific and technological literacy for all.

What is STL ?

Scientific and technological literacy does not only apply to reading and writing about science and technology, but also includes understanding and applying scientific concepts, process skills, attitudes and values which enable a person to relate science and technology to the life and culture of their own society.

STL therefore encompasses :

(i) acquisition of scientific and technological knowledge, skills and attitudes which are necessary to cope with a rapidly changing environment and useful for problem-solving and decision-making in daily life

(ii) appreciation of the nature of science and technology and the development of scientific attitudes and values in relation to other areas of human activity.

How can STL be achieved ?

Scientific and technological literacy cannot normally be acquired through reading but by experience of activities which assist the student (or adult person) to transfer their knowledge and skills by applying them to concrete situations. This requires a a signifiicant shift away from teacher-centred instruction towards more student-centred interactive classroom activities (or out-of-class activities) which may involve the use of some teaching / learning strategies not traditionally associated with science. This has considerable implications for science teacher education.

Asian STL initiatives

A regional workshop on Scientific and Technological Literacy for All in Asia and the Pacific was held in Japan in 1994. Subsequently regional training workshops were held in 1997 to develop STL materials in Pakistan, the Philippines and Korea. A two-year UNESCO project to improve science teaching in middle and secondary schools in Kashmir is using an STL participatory group approach on in-service science teacher training courses. The First Nepal Scientific and Technological Literacy Workshop, at which the materials in this book were initiated, was held in Kathmandu during March 1998. Another workshop to develop STL materials is planned in Bangladesh. SEAAMEO-RECSAM (Malaysia) has also published two sets of STL-type materials for the Science Across Asia Pacific Project.

Appendix II Evaluation of an STL Unit

Evaluation Pro Forma

This form was used for trying out the draft STL units and may be used as a basis for evaluating the units in your school, or for avaluating your own personal STL unit.

School ..... Class.....No. of students.....

Teacher..... ..... Dates used .....for.....lessons.

Your comments on the unit Unit ....

1. With which curriculum topic did you link this unit ? .....

2. Which parts of the unit did you use? (1 tick) Which were most useful ? (2 ticks)

Introduction..... Student Guide/ Resource..... Teachers Guide .....Assessment .....

3. Which of the aims were achieved ? .....

4. List key concepts particularly well covered in the unit .....

5. What extra information/guidance was needed ? .....

Did the unit relate to your own community ? .....

7. Did you as a teacher enjoy using the unit ? ..... Why ?.....

8. Would you use the unit again ?..... Why / why not ? .....

Your opinion of students reaction to the unit

9. Did students find the unit: Motivating .... Interesting .... Boring .... Other.....?

10. List any concepts which students found difficult .....

11. List any practical activities students found difficult .....

12. Did your students do most activities or did you do some ? .....

13. Did this unit enhance students' scientific & technological literacy ? .....

14. Did the students show any unexpected initiative(s) ? .....

Any further comments on this unit (from students or teacher(s)

.....

.....

.....

Please return this form to: CLEST, PO Box 1007, Kathmandu, Nepal

Appendix III References

Workshop References

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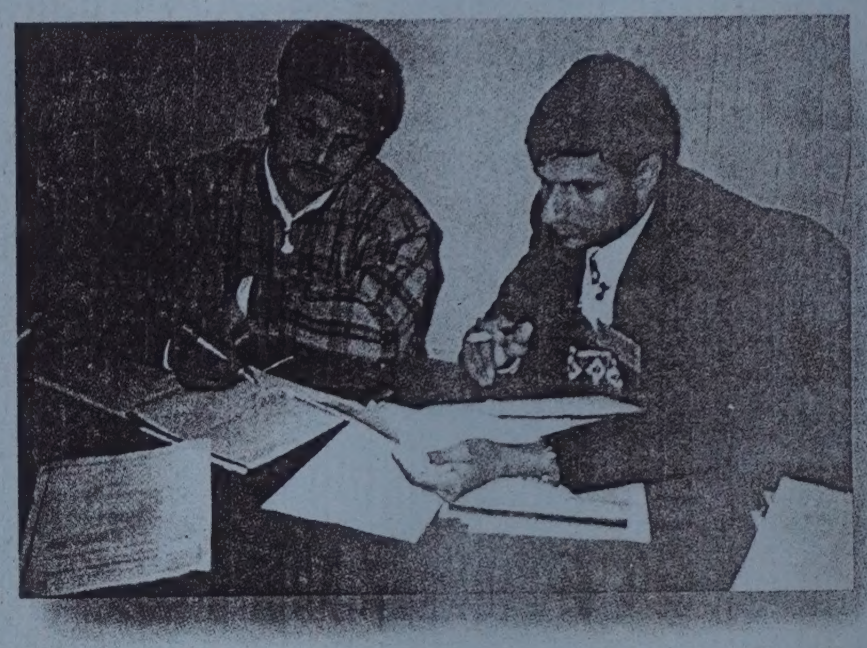
PROMOTING STUDENTS' SCIENTIFIC & TECHNOLOGICAL THINKING

- DEVELOPING SKILLS & ATTITUDES CONCERNING OUR ENVIRONMENT

Edited by Sharada D. Maharjan and Patrick A. Whittle

These materials, which were developed by science teachers in Nepal, are all in response to requests by ICASE and UNESCO to promote the scientific and technological literacy for all people by the new millenium for Project 2000+.



The units, which will be of direct relevance to other developing countries, may there be reproduced for use with students or may be adapted or modified in other countries as enrichment material to heighten global concerns about the Himalayan environment.

Other publications available in this series include :

SUPPLEMENTARY TEACHING MATERIALS -
Promoting scientific and technological literacy [J. Holbrook & M. Rannikmae (Eds) 1997]

TEACHER EDUCATION FOR S.T.L. [J. Holbrook & P. A. Whittle (Eds) 1999]

For further information about these and other ICASE publications contact your local science teachers' association, your ICASE Regional Representative, or you may contact the ICASE Secretariat, c/o A.S.E., College Lane, HATFIELD, Herts, AL10 9AA (U.K.)